Indiana Historic Bridge Inventory

Methodology to Identify Select and Non-Select Bridges

Prepared for

Indiana Department of Transportation

Prepared by

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A MEAD & HUNT **company**

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1. Executive Summary

In fulfillment of Stipulation II.B of the Indiana Historic Bridge Programmatic Agreement (PA) executed August 11, 2006, this report presents a structured methodology "to identify historic bridges that are most suitable for preservation and are excellent examples of a given type of historic bridge." These bridges are referred to as Select Bridges. The multi-step methodology relies on several data inputs to evaluate each historic bridge in a way that is both transparent and replicable. In keeping with Stipulation II.B of the PA, the Indiana Department of Transportation (INDOT), with input from the Historic Bridge Task Group, County Commissioners, and the public, will recommend each historic bridge as either Select or Non-Select. The Federal Highway Administration (FHWA) and Indiana State Historic Preservation Office (INSHPO) will evaluate the recommendations and issue a final list of Select and Non-Select Bridges.

As directed by the PA, this methodology balances engineering and historical considerations to provide a means of classifying bridges as Select or Non-Select. Identification of bridges that are "most suitable for preservation" is based on an Engineering Score that considers the functionality, safety, feasibility, and cost-effectiveness of long-term preservation as measured by a bridge's Sufficiency Rating and Condition Score. Identification of bridges that are "excellent examples of a given type" is based on a bridge's historical significance compared with other bridges of the same structural type, as measured by its Eligibility Score. Eligibility Scores result from evaluations of bridges conducted in 2007 and 2008 to fulfill another requirement of the PA. These scores are documented in the *Indiana Historic Bridge Inventory: National Register Eligibility Results* (to be completed in July 2008). Both Engineering and Eligibility Scores are programmatically applied to the subject population of historic bridges, though individual review of a bridge will be conducted as needed to confirm engineering criteria.

The methodology sets a baseline preservation goal for the identification of Select Bridge candidates within each bridge type. The goal will be exceeded in cases where many excellent examples of a bridge type qualify for select status. Conversely, it is possible that the goal would not be met if bridges within a type fail to meet qualifications. The draft lists of Select and Non-Select Bridges that result from application of the methodology will show whether or not this possibility develops. Agencies will address this potential development during the review period. After considering public comments, the FHWA, in consultation with the INSHPO, will determine and approve the final list of Select and Non-Select Bridges.

It should be noted that the methodology to identify Select Bridges is a tool to be used to fulfill certain requirements of the PA. The PA was executed pursuant to the regulations implementing Section 106 of the National Historic Preservation Act of 1966 (Section 106) (16 U.S.C. 470f). Neither the PA nor this methodology is intended to fulfill requirements of Section 4(f) of the U.S. Department of Transportation Act of 1966 that apply to historic bridges. Application of this methodology, together with the *Treatment of Historic Bridge on Low-Volume Local Road* standards (approved at the March 15, 2007, INDOT Standards Committee meeting), may provide some of the information considered under the Section 4(f) analysis that will be undertaken for an individual bridge during implementation of the project development process defined in the PA.

2. Definitions

Character-defining features – Prominent or distinctive aspects, qualities, or characteristics of a historic property that contribute significantly to its physical character. For historic bridges, such features may include structural or decorative details and materials.

Condition Score – One of two aspects of a bridge's Engineering Score, used together with Sufficiency Rating. The Condition Score is calculated for a historic bridge to assess whether or not the bridge can prudently and economically be preserved in vehicular use. The Condition Score was developed for this methodology to isolate and measure controlling elements to understand if a bridge can be rehabilitated (see Appendix A for more information on Condition Score). It draws from the same NBI data as the Sufficiency Rating but better isolates factors that drive preservation potential.

Eligibility Score – Used to identify bridges that are "excellent examples of a given type," this measures a bridge's historic significance as compared to other bridges of the same structural type. The Eligibility Score results from applying the points system to evaluate the National Register of Historic Places (National Register) eligibility of bridges as part of the Indiana Historic Bridge Inventory. This score is used to rank bridges as High, Medium, or Low (see *Figure 3. Selection Matrix* for more information).

Engineering Score – Used to identify bridges that are "most suitable for preservation," this assessment of a bridge has two aspects: Condition Score and Sufficiency Rating. Both aspects are considered in ranking bridges as High, Medium, or Low (see *Figure 3. Selection Matrix* for more information).

Functional obsolescence – The FHWA classification of a bridge that cannot meet current traffic needs because of inadequate horizontal or vertical clearance, inadequate load-carrying capacity, and/or insufficient opening to accommodate water flow under the bridge. While structural deficiencies are generally the result of deterioration of bridge components, functional obsolescence results from changing traffic demands on the structure.

Historic bridge – A bridge that has been listed in or determined eligible for the National Register. According to the methodology used for this project, bridges with an Eligibility Score of 1 or greater are considered eligible for listing in the National Register.

National Bridge Inventory (NBI) – Bridge inventory and appraisal data collected by the FHWA to fulfill the requirements of the National Bridge Inspection Standards. Each state maintains an inventory of its bridges subject to these standards and sends an annual update to the FHWA.

Non-vehicular bridge – A bridge that has been closed, bypassed, or relocated and carries no motorized vehicles. Only a small number of non-vehicular bridges located within the public right-of-way are considered in this project (see *Section 3 - Applicability*).

Preservation – As used in this report, this term refers to historic preservation that is consistent with the Secretary of the Interior's *Standards for the Treatment of Historic Properties*. Historic preservation means saving historic bridges from destruction or deterioration, and providing for their continued use by means of restoration, rehabilitation, or adaptive reuse. It is the act or process of applying measures to sustain the existing form, integrity, and material of a historic bridge, and its site and setting. The FHWA's Highway Bridge Replacement and Rehabilitation Program (HBRRP) describes preservation differently, focusing on repairing or delaying the deterioration of a bridge whether classified as historic or not.

Structurally deficient – Classification indicating poor structural condition for any of the following: deck, superstructure, substructure, or culvert (if applicable). A structurally deficient bridge is restricted to lightweight vehicles; requires immediate rehabilitation to remain open to traffic; or requires maintenance, rehabilitation, or replacement.

Sufficiency Rating - One of two aspects of a bridge's Engineering Score, used together with Condition Score. In this methodology, the Sufficiency Rating is used to provide an initial indication of whether a bridge is sufficient, as well as a means to check the more detailed Condition Score. The Sufficiency Rating is a method of calculating data for a vehicular bridge to obtain a numeric value indicative of the bridge's sufficiency to remain in service. The result of this method is a percentage in which 100 percent represents an entirely sufficient bridge and zero percent represents an entirely insufficient, or deficient, bridge. The four factors used to calculate this percentage are: 1) structural adequacy and safety (determined by the condition and load capacity characteristics of the bridge), 2) serviceability and functional obsolescence (determined with traffic level and geometric characteristics), 3) essentiality for public use (traffic levels, detour lengths), and 4) special reductions (i.e., lack of safety features). See the FHWA's *Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges* for more information.

Vehicular bridge – A bridge that actively carries traffic on the local or state roadway system.

3. Applicability

This methodology will be applied to Indiana's historic bridges located on public roads and within the public right-of-way. Historic bridges in Indiana include bridges recommended eligible as part of the Indiana Historic Bridge Inventory and bridges that were previously determined eligible or listed in the National Register, including contributing resources in historic districts. A small number of historic bridges no longer carry traffic and are classified as "non-vehicular." The following categories of bridges are excluded:

1. Bridges built after 1965

2. Bridges that are privately or railroad owned

3. Bridges for which INDOT does not have primary maintenance responsibility (including select border bridges and bridges maintained by other state and federal agencies)

4. Methodology

As stipulated in the PA for Indiana's historic bridges, this methodology will "identify historic bridges that are most suitable for preservation and are excellent examples of a given type of historic bridge." Such bridges are referred to as Select Bridges. To achieve balance between engineering and historical considerations, two scores are used to determine Select Bridge candidates. The Engineering Score, which is comprised of the Condition Score and the Sufficiency Rating, identifies bridges that are "most suitable for preservation." The Eligibility Score identifies bridges that are "excellent examples of a given type" based on historic significance as compared to other bridges of the same type. *Figure 1* illustrates the overall process for identifying Select and Non-Select Bridges.

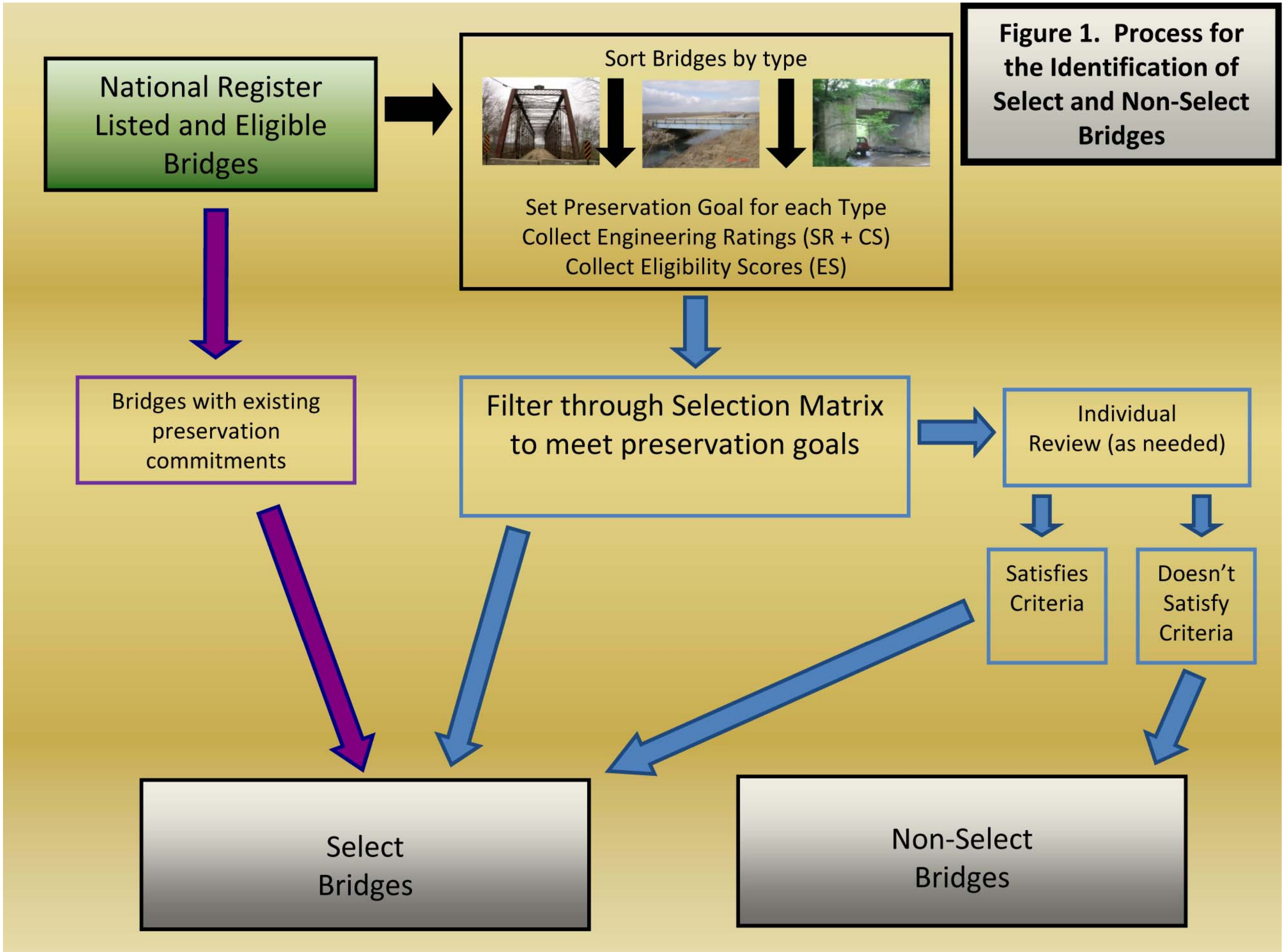


Figure 1. Process for the Identification of Select and Non-Select Bridges
National Register Listed and Eligible Bridges
Sort Bridges by type
Set Preservation Goal for each Type
Collect Engineering Ratings (SR + CS)
Collect Eligibility Scores (ES)
Bridges with existing preservation commitments
Filter through Selection Matrix to meet preservation goals
Individual Review (as needed)
Satisfies Criteria
Doesn't Satisfy Criteria
Select Bridges
Non-Select Bridges

Step 1: Prepare data for review

- Sort historic bridges into bridge types, as indicated in the left-hand column of Tables 1 and 2.

- Confirm existing preservation commitments for historic bridges. Most of these are non-vehicular bridges. Such bridges are categorized as Select Bridge candidates and no additional evaluation is conducted.

- Collect Sufficiency Rating from the NBI database, if available. The Sufficiency Rating of a bridge, which is based on an inspection, is calculated biennially and submitted to the FHWA as part of the NBI database.[1] The Sufficiency Rating provides a comprehensive evaluation of the current condition of the bridge, including safety and public use factors. However, some factors of the Sufficiency Rating do not directly apply to whether a structure can be maintained into the future. Because of this, the Condition Score was developed as a method to isolate items that do directly apply to whether a bridge can be preserved.

- Compute Condition Score according to the *Condition Score Matrix* illustrated in Appendix A. The Condition Score isolates factors that typically control whether a bridge can be prudently and economically rehabilitated and therefore preserved in vehicular use.

- Collect Eligibility Score from the *Indiana Historic Bridge Database* for each historic bridge. The Eligibility Score of each bridge is used to rank its historic merit so that excellent examples of a given type can be given priority (see *Figure 2. Eligibility Score Values*). Bridges that were previously determined eligible for or listed in the National Register, including those that are contributing resources in historic districts, were not evaluated during the inventory project. Each of these bridges receives a high value for purposes of applying this methodology. Bridges with a high value are considered to be excellent examples of their respective types.

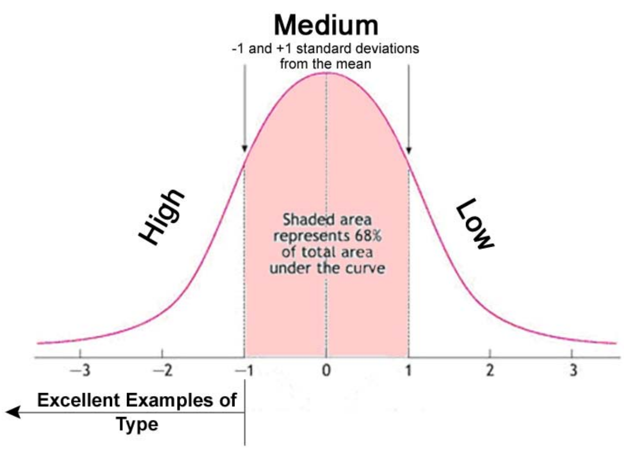


Figure 2. Eligibility Score Values

[1] The Sufficiency Rating of a bridge is used by the FHWA to determine if it is eligible for federal funding. Bridges with a Sufficiency Rating below 80 are eligible for rehabilitation dollars, while those with a rating below 50 are eligible for replacement. NBI condition ratings of 5 or better indicate satisfactory condition.

Step 2: Conduct quality review of data

- Review historic bridges that have components with poor NBI condition ratings (e.g. superstructure, deck or substructure rated 4 or below) and revise ratings, if warranted. Bridges with components that are rated in poor condition have been flagged and images of these components were collected during field review. These images will be reviewed to assess appropriateness of poor component ratings. Any revision of ratings will be made in consultation with INDOT. Such revisions would affect a bridge's Sufficiency Rating and Condition Score.

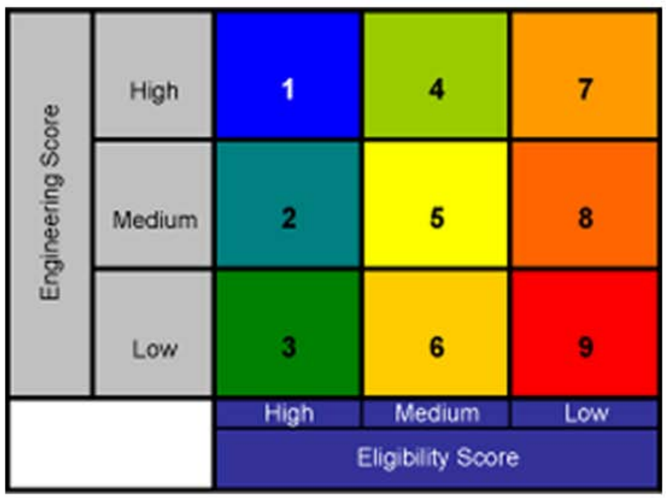
- Compare Condition Score and Sufficiency Rating to identify historic bridges with large numerical differences and work with INDOT to reconcile. This may involve completing limited field inspection. This ensures that bridges with a low Sufficiency Rating are evaluated thoroughly for their preservation potential as measured by the Condition Score.

Step 3: Sort bridges into Selection Matrix

- Sort the pool of historic bridges within each bridge type based on each bridge's Engineering and Eligibility Scores (see *Figure 3. Selection Matrix*). The matrix defines high, medium, and low values for both Engineering and Eligibility Scores. It was developed for this methodology as a tool to determine a bridge's priority for consideration as a Select Bridge.

- Proceed to place each bridge into the appropriate box. For example, a bridge with both a high Engineering Score and a high Eligibility Score is placed into Box 1. Likewise, a bridge with both a low Engineering Score and a low Eligibility Score is placed into Box 9.

Figure 3. Selection Matrix



Eligibility Score:

High values are more than 1 standard deviation above the mean value for the bridge type

Medium values are within 1 standard deviation of the mean value for the bridge type

Low values are less than 1 standard deviation below the mean value for the bridge type

Engineering Score:

High values have a Condition Score >= 40 and a Sufficiency Rating >= 50

Medium values have a Condition Score = 35-39 and a Sufficiency Rating >= 40

Low values have a Condition Score < 35 or a Sufficiency Rating < 40

Step 4: Establish preservation goals

A preservation goal is established for common and uncommon bridge types, within Indiana's total population of historic bridges subject to this project (see *Section 3 - Applicability*). Common types have pre-1966 populations of 100 or more and often continued to be built after the subject period. Uncommon types have pre-1966 populations of less than 100 (in most cases, far smaller) and were rarely built after the subject period.

Normal Distribution Curve

A normal distribution curve, also referred to as a bell-curve, defines a normally distributed set of data. Within a normal distribution of scoring data, an average score and a standard deviation from that average score will occur. In this methodology, the concept of normal distribution is used to establish preservation goals for common and uncommon bridge types and to define excellent examples within each bridge type.

A standard deviation is a measure of the variation among the data points. As shown in the pink shaded area, approximately 68% of the population will have a score within one standard deviation of the average of all scores. Based on the concept of normal distribution, 16% of the population will have scores greater than the average score plus one standard deviation and 16% of the population will have scores lower than the average score minus one standard deviation.

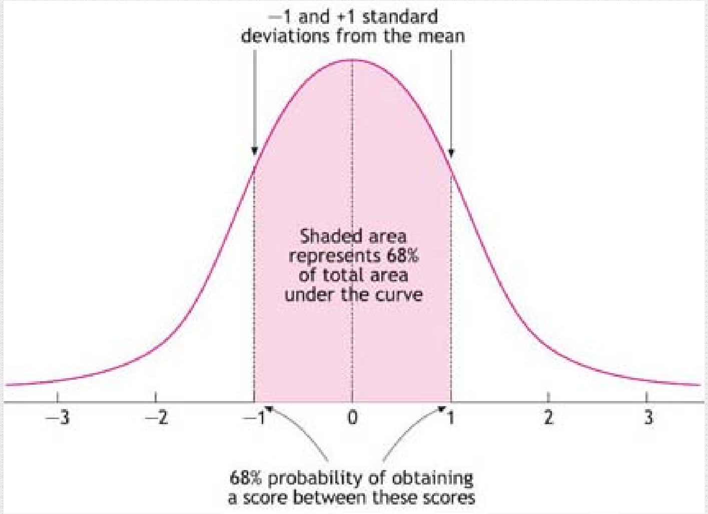


Figure 4. Illustration of Normal Distribution

(Source: C.P. Dancey and J. Reidy, Statistics Without Maths for Psychology, 2nd ed. (Harlow, Pearson Education, 2002).

The recommended preservation goal for each bridge type is achieved by applying the concept of normal distribution. Simply stated, a normal distribution of data means that most of the examples in a set of data are close to the "average," while relatively few examples tend to one extreme or the other (see sidebar at left). The concept of normal distribution is applied to bridge types to establish a preservation goal in the following manner:

- Common bridge types are set at 16% of the historic bridge population
- Uncommon bridge types are set at 84% of the historic bridge population

For common bridge types, the threshold of 16% captures the probable best examples within a common type while eliminating the average and least satisfactory examples. Sixteen percent represents bridges that score greater than 1 standard deviation from the mean. In this case, the methodology is working to identify candidates within common bridge types that are statistically the best or top examples.

For uncommon bridge types, the threshold of 84% captures the majority of the population. By selecting the top 16% and the average (those that score within one standard deviation of the average), a preservation goal of 84% works to capture the population that is both the best and average while eliminating the lowest scoring and, therefore, the least satisfactory examples to be preserved. In this case, the methodology is working to identify the maximum number of candidates of uncommon bridge types due to a smaller population and/or greater threats to their continued existence. *Figure 5* shows the percentages of common and uncommon bridge types on a normal distribution curve.

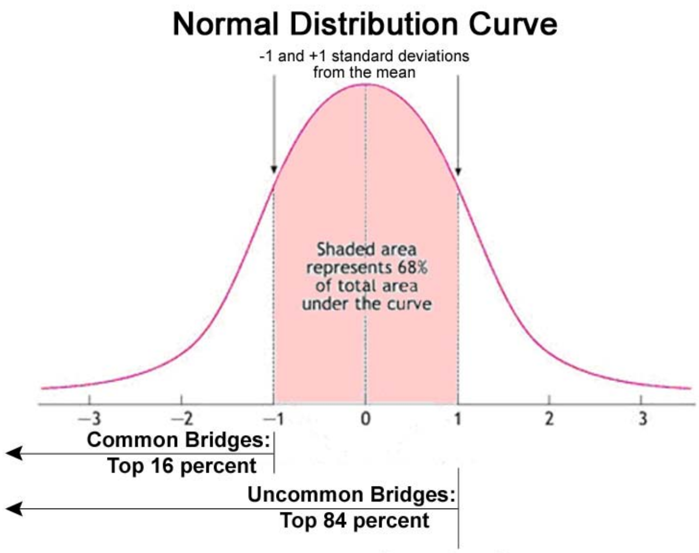


Figure 5. Preservation Goal for Common and Uncommon Bridge Types

The preservation goals recognize that uncommon bridge types, such as timber covered and iron truss bridges, warrant a greater targeted percentage for preservation than common bridge types, which continue to be built after 1965. Covered and iron truss bridges date from an earlier era of bridge construction and are often more threatened due to their limited function when assessed by modern engineering standards. Uncommon types also tend to be those most important to the preservation community and public. More recently introduced bridge types, such as prestressed concrete I-beams, have a greater level of function based on modern engineering standards, as evidenced by the fact that this bridge type continues to be built. If engineering criteria alone drove the model to identify Select Bridges, the resulting preservation recommendations would skew the selection toward more recent bridge types.

Tables 1 and 2 identify which bridge types are recognized as common and uncommon. Preservation goals are set for each bridge type identified in the left-hand column. Bridge types are groups of bridges with similar structural members and material composition as identified through detailed NBI/INDOT codes in the right-hand column.

Table 1
Common Bridge Types

Bridge types	NBI/INDOT code and type
Metal plate and pipe arch	311 – Metal pipe arch 319A – Multiplate – under fill 911 – Aluminum arch 919B – Aluminum multiplate arch – under fill
Metal pony truss (common)	310A – Warren 310A – Pratt
Metal thru truss (common)	310B – Warren 310B – Parker 310B – Pratt
Prestressed concrete box beam	505, 506 – Prestressed concrete box beams – multiple/spread 605, 606 – Continuous prestressed concrete box beams – multiple/spread
Prestressed concrete I-beam	502, 504 – Prestressed concrete I-beam/tee beam 602 – Continuous prestressed beam
Reinforced concrete arch (common)	111A, 119B, 119E – Reinforced concrete arch/arch – under fill; Precast concrete arch – under fill 211 – Continuous reinforced concrete arch
Reinforced concrete girder and beam	102A, 102B, 104 – reinforced concrete girder/beam/tee beam 103 – Reinforced concrete girder – trans. girder/floor beam system 105 – Reinforced concrete box girder – multiple 119D – Reinforced concrete girder – under fill 122 – Precast concrete beam/channel beam 202A, 204 – Continuous reinforced concrete girder/tee beam 203 – Continuous reinforced concrete girder - trans. girder/floor beam system 205 – Continuous reinforced concrete box girder – multiple
Reinforced concrete slab	101A – Reinforced concrete slab 119A – Reinforced concrete slab – under fill 201A – Continuous reinforced slab
Steel beam	302A, 302D, 302G, 303C, 303H 402A, 402C, 402D

Table 2
Uncommon Bridge Types

Bridge types	NBI/INDOT code and type
Metal arch	312B – Thru steel arch
Metal pony truss (uncommon)	310A, 310C – Other variations 910B – Iron
Metal thru truss (uncommon)	310B – Other variations 910A – Iron
Reinforced concrete arch (uncommon)	111B – Open spandrel reinforced concrete arch 112 – Thru reinforced concrete arch 111C – Unreinforced concrete arch
Reinforced concrete rigid frame and box	107A – Reinforced concrete rigid frame/box 119C – Reinforced concrete box – under fill 207A, 207B – Continuous reinforced concrete rigid frame/box 219B – Continuous reinforced concrete box – under fill
Steel deck truss	309
Steel girder	302B, 302C, 302E, 302H, 303B, 303E, 303F, 402B, 402E, 402H, 402I, 403A, 403B, 403C, 403D
Steel movable	316 – Bascule
Stone	811 – Stone arch 819 – Masonry culvert – under fill
Timber, other	701 – Timber slab 702A – Timber beam 702B – Timber girder 702C – Timber trestle
Timber truss	710 – Timber covered bridge

Step 5: Filter bridges through sequencing process

This step involves filtering bridges through a sequence designed to identify excellent examples of each type that are most suitable bridges for preservation. Historic bridges are prioritized using the filtering process described below. Bridges within each type are placed into the appropriate box as illustrated by *Figure 3. Selection Matrix*. The sequencing process shown in *Figure 6* is applied until the preservation goal for each bridge type is met.

At a minimum for each bridge type, historic bridges in Boxes 1-3 (i.e. those with a high Eligibility Score) are considered as Select Bridge candidates. It is important to note that bridges in Boxes 1 and 2 are programmatically determined to be Select Bridges based on their high Eligibility Scores and high or medium Engineering Scores. For bridges in Box 3, individual review of a bridge is conducted to determine if it satisfies the criteria for preservation (see Step 6 below). If a bridge in Box 3 satisfies the criteria, it will be considered a Select Bridge.

The preservation goal for any bridge type can be exceeded if a greater number of bridges in Boxes 1-3 are classified as Select Bridges (see sidebar at right and *Figure 6a*). If the preservation goal has not been met in Boxes 1-3, the filtering sequence continues until the preservation goal for that bridge type has been met (see sidebar at right and *Figure 6b*). Specifically, bridges within Box 4 are considered next, then those in Box 5, and so on as needed until the goal is met. This method allows the next best examples within each bridge type that are in the best possible engineering condition to be identified as Select Bridges.

Examples of Filtering Sequences to Meet Preservation Goal

Figures 6a and 6b outline hypothetical sequencing processes for two common bridge types. In Figure 6a, the historic bridge population is 47 and the preservation goal is 16 percent, or eight bridges. Ten bridges have high Eligibility and high or medium Engineering Scores that place them in Boxes 1 and 2, thus programmatically qualifying them as Select Bridges. Eight bridges have scores that place them in Box 3, and individual review is conducted for each of these bridges. Individual review determines that five bridges satisfy criteria for preservation and are Select Bridges. Three bridges do not satisfy criteria for preservation and are Non-Select Bridges. Therefore, fifteen bridges are identified as Select Bridges, exceeding the preservation goal of eight.

In Figure 6b, the historic bridge population is 100 and the preservation goal is 16 percent, or 16 bridges. Eight bridges in Boxes 1 and 2 are programmatically determined to be Select Bridges, and five bridges in Box 3 undergo individual review. Individual review determines that four bridges satisfy criteria for preservation, while one bridge does not. Therefore, the sequencing process results in 12 bridges from Boxes 1, 2, and 3 being identified as Select Bridges. Because the preservation goal is not yet met, the sequencing process continues to assess bridges in Box 4. The Eligibility Scores of the 10 bridges in Box 4 are sorted from high to low to identify "excellent examples," and the four bridges with the highest scores are determined Select Bridges. The preservation goal of 16 bridges is then met, and the remaining six bridges in Box 4 are determined Non-Select Bridges. Bridges in Boxes 5-9 are not considered.

Figure 6. Filtering Sequence for Selection Matrix: Historic Bridge Pool for X Type

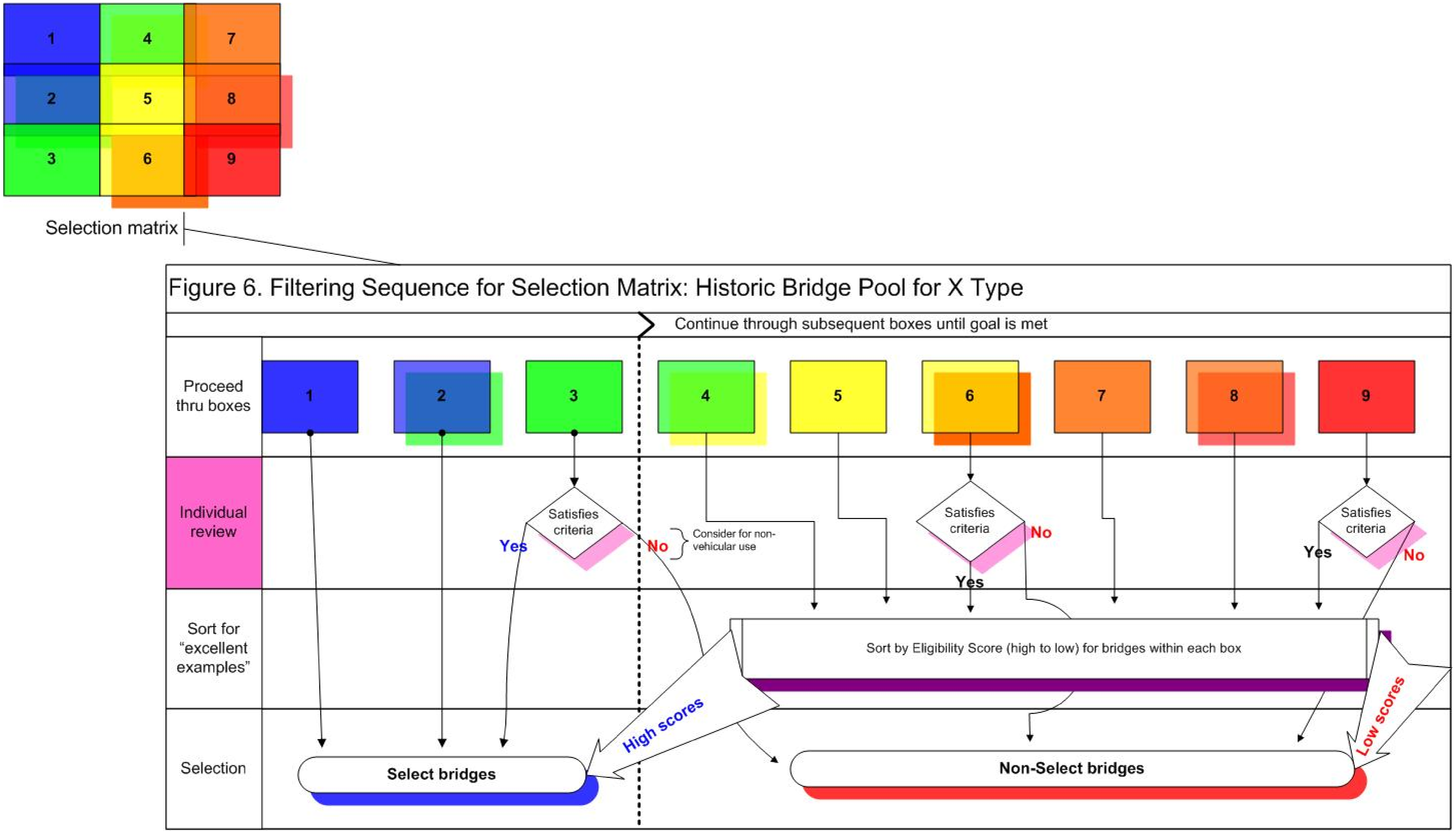


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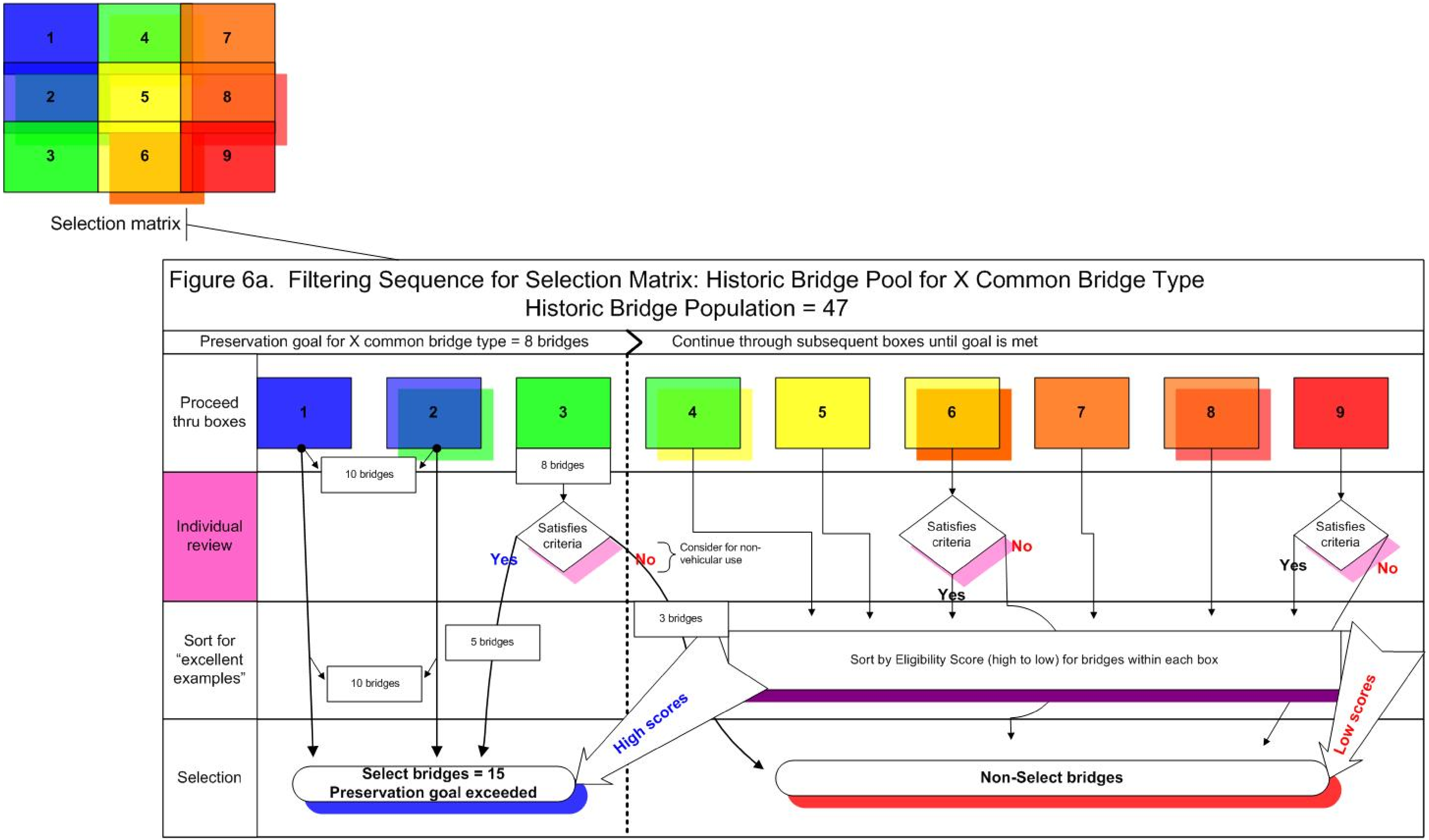
Figure 6a. Filtering Sequence for Selection Matrix: Historic Bridge Pool for X Common Bridge Type
Historic Bridge Population = 47



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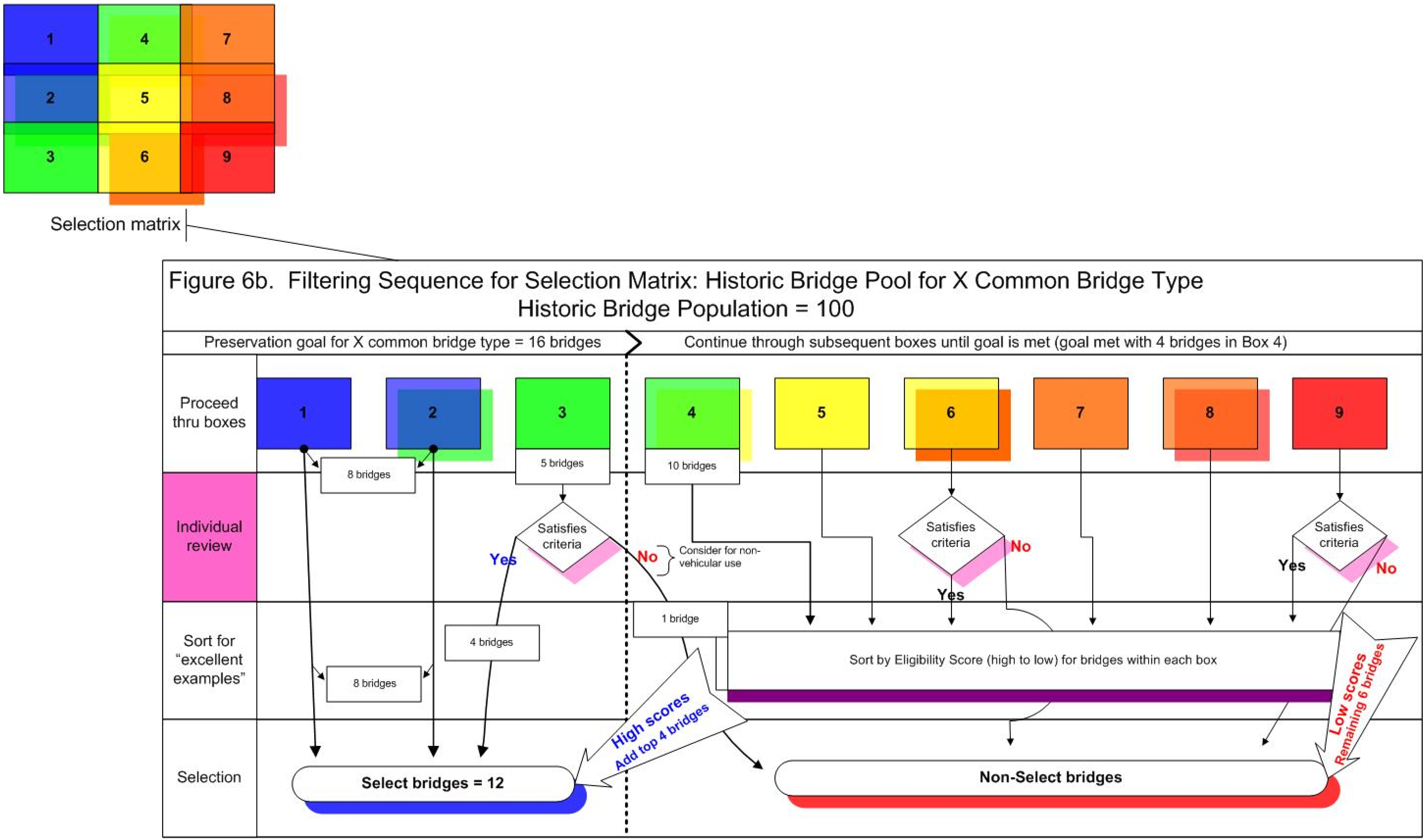
1
4
7
2
5
8
3
6
9
Selection matrix
Figure 6b. Filtering Sequence for Selection Matrix: Historic Bridge Pool for X Common Bridge Type
Historic Bridge Population = 100
Preservation goal for X common bridge type = 16 bridges
Continue through subsequent boxes until goal is met (goal met with 4 bridges in Box 4)
Proceed thru boxes
Individual review
Sort for "excellent examples"
Selection
1
2
3
4
5
6
7
8
9
8 bridges
5 bridges
10 bridges
Satisfies criteria
Yes
No
Consider for non-vehicular use
Satisfies criteria
No
Yes
Satisfies criteria
Yes
No
1 bridge
4 bridges
8 bridges
Sort by Eligibility Score (high to low) for bridges within each box
High scores
Add top 4 bridges
Low scores
Remaining 6 bridges
Select bridges = 12
Non-Select bridges

Step 6: Individual review

For bridges in Box 3, individual review of a historic bridge is conducted to determine if it satisfies the criteria for preservation. This same process applies to any historic bridge in Box 6 or 9 that is considered for Select Bridge status (i.e. for bridge types where the preservation goal is not met earlier in the filtering sequence). For a bridge requiring individual review, proceed to:

- Identify deficiencies leading to low Condition Score from Condition Score Matrix.
- Identify character-defining features from the *Historic Bridge Database* and field survey photos.
- Apply the series of checks, as outlined in *Figure 7*. Individual Review Process, to individually review bridge candidates. The maximum number of points a candidate bridge can receive is 100. The points are determined from the Condition Score (multiplied by 0.25), the Eligibility Score, and points awarded based on the outcome of five checks as follows:

    1. To determine the capability to bring the primary components of the bridge (superstructure and substructure) to a satisfactory condition (NBI condition 5 or better). If the primary components are in poor condition, it will take more resources to preserve the bridge on a long-term basis.

    2. To identify if the bridge has adequate load capacity for the roadway system. A bridge may be in excellent condition but have marginal load capacity. Bridges with adequate load capacity are better candidates for long-term preservation. If the bridge is on a low-volume roadway, determine if it meets the low-volume test (see Appendix B for Low Volume Road Matrix).

    3. To check the bridge's geometrics, consider whether or not it is functionally obsolescent. Check to see if the clearances, lane widths, and shoulder widths are appropriate for the roadway system. Functionally obsolete bridges are more difficult to maintain on a vehicular system. This check also includes considerations for low-volume roads.

    4. To determine if deficiencies of the bridge are associated with the character-defining features. The potential for rehabilitation to address deficiencies is considered in this check. Any needed improvements, such as widening or strengthening, are assessed to see if they can be accomplished without negatively affecting character-defining features and thus compromising a bridge's historic integrity. If major deficiencies are associated with the character-defining features, there is a greater likelihood the historic integrity of the bridge would be lost through required preservation efforts.

    5. To assess additional factors relevant for long-term preservation, including:

        - Use of salts (based on owner's information and/or visual inspection) – Bridges that have been salted to prevent icy conditions during the winter are likely to be contaminated with chlorides. If the salted bridge is contaminated with chlorides, it could readily lead to accelerated deterioration. This primarily impacts concrete bridges (both conventionally reinforced and prestressed); however, paint systems on the steel bridges can be contaminated with chlorides as well, which impact future coating decisions.

- Sag vertical curves – Bridges located in sag vertical curves are likely to have additional roadway drainage, which may accelerate deterioration of components. Sag vertical curves connect the roadway grades on each side of a depressed feature (e.g. a valley). They typically contain the "low point" of a section of roadway that receives roadway drainage from two directions.

- Open deck joint details – Permit roadway drainage to accelerate the deterioration of components.

- Unusually high accident rates – Indicate safety issues that need to be addressed.

- Long detours – Bridges with inadequate load capacity requiring long detours (greater than 10 miles) for emergency vehicles are less attractive for long-term preservation.

- If a bridge in Box 3 fails checks 1, 2, or 3, it will be considered for preservation as a non-vehicular bridge. If primary components of the structure can be restored to an acceptable level for non-vehicular use without destroying character-defining features and a preservation commitment can be established, the bridge will be considered a Select Bridge. This allows bridges that are the best examples within a type to be thoroughly considered for continued preservation. Bridges in other boxes are not considered for preservation in non-vehicular use.

- When reviewing structures in Boxes 6 and 9, sort bridges in each box by highest Eligibility Score. Continue to perform individual reviews for bridges with the highest Eligibility Scores until the preservation goal is met for each bridge type.

Figure 7. Individual Review Process

Candidate Bridge

Identify bridge deficiencies leading to low cond. score (points = 0.25 x CS, max 10)

Review eligibility scoring (points = 0.5 x ES, max 10), Identify character-defining feat.

Maximum individual review score is 100 points.
* Consider non-vehicular preservation if high Eligibility Score

Check 1: Can the existing superstructure and substructure be restored to an NBI condition 5?
- yes: Better candidate for long-term preservation (25 points)
- no: Less desirable candidate for long-term preservation (0 points)*

Check 2: Does the bridge meet minimum load capacity standards for the functional class of the roadway?
- yes: Better candidate to carry vehicles (20 points)
- no: Less desirable candidate to carry vehicles (0 points)*

Check 3: Is the bridge functionally obsolete?
- no: Better candidate to carry vehicles (15 points)
- yes: Less desirable candidate to carry vehicles (0 points)*

Check 4: Are major deficiencies tied to character-defining features?
- no: Rehabilitation less likely to compromise historic integrity (15 points)
- yes: Rehabilitation more difficult to execute to retain historic integrity (0 points)

Check 5: Additional factors: salted roadway, sag vertical curve, open deck joints, high accident rate, long detour?
- no: 1 point for each factor answered no
- yes: 0 points

Step 7: Agency review

In accordance with the PA, the Historic Bridge Task Group, County Commissioners, and the public will be provided an opportunity for review and comment of the draft list of Select and Non-Select Bridges that results from the application of this methodology. After consideration of comments received from these interested parties, the FHWA, in consultation with the INSHPO and in cooperation with INDOT, will review and approve a final list of Select Bridge candidates. As a result of comments received, the FHWA and the INSHPO may:

- Increase or decrease the number of Select Bridge candidates within any bridge type.
- Consider other factors not provided in the methodology, such as:
  - Documented development pressure
  - Community support and/or anticipated future preservation commitments
  - Location within a potential historic district
  - Geographic distribution of bridges
  - Other special circumstances as defined during the review of comments and consultation between the FHWA, INDOT, and INSHPO

5. Special Circumstances and Periodic Updates

This report provides a methodology to identify Select and Non-Select Bridges as stipulated in Indiana's PA for historic bridges. The methodology applied to identifying Select Bridge candidates provides a consistent and replicable approach to identifying the best candidates for preservation. However, there may be rare situations when the status of an individual bridge will require reconsideration. Stipulation II.C of the PA provides for the reevaluation of a Select Bridge if unusual circumstances lead to the bridge no longer being able to meet the criteria outlined in this methodology. This stipulation reads:

> 1. In unusual circumstances, a Select Bridge may no longer meet the Select Bridge criteria. Examples of unusual circumstances may include, but are not limited to, the bridge collapsing due to a flood or an overweight vehicle. A bridge owner may request that FHWA and the Indiana SHPO re-evaluate the Select Bridge determination if an unusual circumstance occurs. The following process will be followed to determine if re-classification of the Select Bridge is appropriate:
>
> > a. The bridge owner must submit the request in writing to INDOT. The bridge owner should describe the unusual circumstance that has occurred and explain why the Select Bridge criteria no longer apply to the bridge.
> >
> > b. If INDOT determines the request has merit, then INDOT will notify FHWA, the Indiana SHPO, the Task Group, and the public of the request to re-classify the Select Bridge. INDOT will accept comments from the Task Group and the public for thirty (30) days.
> >
> > c. INDOT will provide a copy of all comments received to FHWA and the Indiana SHPO. FHWA and the Indiana SHPO will consult to evaluate the request and consider the comments received from the Task Group and the public.
> >
> > d. If FHWA and the Indiana SHPO agree on the classification of the bridge, then FHWA will notify INDOT of the decision within 30 days after receiving the documentation from INDOT. INDOT will notify the bridge owner, the Task Group and all individuals that provided comments on the bridge of the decision. If FHWA and the Indiana SHPO do not agree on the classification of the bridge, then the parties will invoke the Dispute Resolution provision, Stipulation IV.B. If necessary, INDOT will update the Select/Non-Select list by removing the Select Bridge from the list.
>
> 2. At least every ten (10) years, FHWA, INDOT, and the Indiana SHPO will consult to determine if conditions have changed that would require updating the list of bridges eligible for the NRHP, the criteria for identifying Select and Non-Select Bridges, and the list of Select and Non-Select Bridges. Any signatory may request that an update be completed more frequently if there have been substantial changes to the population of bridges identified in the Bridge Survey. If FHWA, INDOT and the Indiana SHPO agree that conditions have changed and an update is required, then the survey will be completed as described in Stipulation II of this Agreement. The FHWA, INDOT and the Indiana SHPO will consult to determine if the survey should be expanded to include bridges built after 1965. If FHWA, INDOT and the Indiana SHPO determine the existing survey is still valid, then INDOT will notify the Task Group, County Commissioners, and the public of the decision.

The PA is available on the INDOT project website at http://www.in.gov/indot/7035.htm.

Appendix A Condition Score Matrix

Condition Score Matrix

The *Condition Score Matrix* was developed for this project as a tool to estimate the potential for preservation of historic bridges that carry vehicular traffic. The matrix automates the screening process by isolating factors that typically control whether a bridge can be prudently and economically rehabilitated and therefore preserved. The Condition Score also provides an early indication of the condition of a bridge by isolating controlling elements. Values utilized in the matrix are extracted from the National Bridge Inventory (NBI) database as follows:

- Superstructure condition
- Substructure condition
- Structural capacity
- Overall structural evaluation
- Roadway width compared to ADT
- Roadway width compared to approach width
- Deck geometry evaluation
- Waterway adequacy
- Approach roadway evaluation

The *Condition Score Matrix* compares the NBI values and assigns a score for each item listed to arrive at a composite score (see the following page for a sample). The individual values are tabulated in the matrix to arrive at a Condition Score. Values of 40 or more indicate a greater potential for preservation. This value, which was calculated from a representative sample of historic bridges, is the mean plus one standard deviation. Those bridges with a Condition Score value of 40 or greater place in the upper 16% of the sample bridge population. Lower values indicate a bridge that has elements in poor or critical condition and therefore is less suitable for preservation. Bridges with a high or medium Engineering Score, as partially determined by Condition Score, are programmatically considered for Select Bridge status. Bridges with a low Engineering Score have their potential for preservation considered during an individual review (see *Figure 6. Filtering Sequence for Selection Matrix*).

Indiana Historic Bridge Inventory - Condition Score Matrix

M & H Architecture, Inc.
a MEAD HUNT company

NBI Number				NBI Number	Assesment
	Structure Number	**00227**	**3200173**		
	Structure Type: =	**111A**	**Simple R/C Arch**		
	Location:	**Hendricks**	**County**		
	Criteria				
64B	Structural Capacity (Tons)			16	2.2
67	NBI Structural Evaluation			4	4.0
59	NBI Superstructure Rating			5	5.0
60	NBI Substructure Rating			5	5.0
51/114	Roadway Width Compared to ADT (NBI Factor H)			1	4.6
51/32	Approach Width Compared to Bridge Roadway Width				0.0
68	NBI Deck Geometry Evaluation			3	0.0
71	Waterway Adequacy			7	5.0
72	NBI Approach Roadway Alignment Evaluation			4	4.0
	Total Condition Score				**29.8**

DATA INPUT FROM NBI RECORDS

28	Number of Lanes	1.0			
29	ADT=	198	SR Factor H	1.13	
30	ADT Year =	2002			
32	Approach Width=	21.0	(X)	ADT/Lane =	198
51	Roadway Width	17.7	(Y)	Width/Lane=	17.7
59	NBI Superstructure Rating	5			
60	NBI Substructure Rating	5	Assessment Legend		
64B	Struct Cap.=	16		Indicates User Input Required or Values Read from NBI	
67	NBI Structural Evaluation	4		Indicates assigned values corresponding to the NBI rating with a	
68	NBI Deck Geometry Evaluation	3		maximum value of 5 to a lower value of 0	
71	Waterway Adequacy	7			
72	Approach Alignment Evaluation	4			
114	Future ADT	294.0	If less than 400 then use Low Volume Matrix		
115	Future ADT Year	2022			

Appendix B Low Volume Road Matrix

Low Volume Road Matrix

The *Low Volume Road Matrix* was created to provide an initial screening for bridges with a future Average Daily Traffic (ADT) less than 400 to determine if the bridge would pass the structural capacity and bridge width criteria listed in the *Indiana Design Manual Section 72-7.0, Treatment of Historic Bridge on Low-Volume Local Road*. The future ADT is the same measure used in these low-volume road standards. The matrix tests the structural and functional criteria shown in Figures 07-05A and 07-05B. If a "yes" value is returned from both tests, that particular bridge will satisfy the criteria without modification and can be considered as a Select Bridge candidate. If a "no" value is returned, the bridge would need individual review.

Indiana Historic Bridge Inventory - Low Volume Road Matrix

M & H Architecture, Inc.

a MEAD & HUNT company

NBI Number	Structure Number 00227 3200173 Structure Type 111A Simple R/C Arch Structural Criteria	Detour Length < 5Mi	5 mi <= Detour Length < 10 Mi	Detour Length >10 Mi
64B	Structural Capacity (Tons)	15-27	27	27-36
114	Future ADT < 100	no	no	no
114	100 < = Future ADT < = 400	no	no	no
	Functional Criteria			
51	Bridge Width (feet)	15-16	18-20	
28	Lanes on Bridge	1	1	
114	Future ADT < 100	no	no	
114	100 < = Future ADT < = 400	yes	no	

DATA INPUT FROM NBI RECORDS

19	Detour Length	1
51	Roadway Width =	17.7
28	Number of Lanes	1
114	Future ADT	294
64B	Struct Cap.=	16